10/581898
AP3 Rec'd PCT/PTO 05 JUN 2006

[001] # PROTECTIVE CLOTHING FOR THE LOWER PART OF THE LEG

[002]

[003]

[004] This invention relates to lower leg protective apparel, in particular protective socks, against chemical and/or biological noxiants.

[005]

[006] Lower leg protective apparel is known in the civilian field, in particular in the medical field. For instance, EP 0 705 543 B1 describes a lower leg protection garment which is said to provide a taping effect as a measure to prevent injury, or the recurrence of an injury, during sports or training activities.

[007] Waterproof breathable socks are also known (see for example EP 0 386 144 B1).

[008] DE 199 18 425 A1 describes a protective shoe in which an inner shoe is configured as a stocking using a breathable membrane.

[009] EP 1 269 877 describes a protective suit in the form of an overall for protection against chemical noxiants.

[010] The disadvantage with known protective suits against chemical and/or biological noxiants in the military field is that they only reach as far as the ankle and thus leave the feet unprotected. Overboots made of 100% butyl are used to protect the feet.

[011] However, a disadvantage with this is that the boots can only be put on once the solider has put on the protective suit. But since the protective suits are usually very stiff, it is comparatively difficult to pull on the overboots. Nor are the known overboots breathable and they are comparatively cumbersome and large. Moreover, since they are separate from the protective suits they also liable to be lost.

[012]

[013] The present invention therefore has for its object to provide lower leg protective apparel, in particular a protective sock which avoids the aforementioned disadvantages, in particular which offers a high wear comfort and can be worn like a conventional sock or stocking.

[014] This object is achieved according to the present invention by lower leg protective apparel, in particular a protective sock which has a plurality of

plies, comprising an outside leg part and, disposed in the interior of the outside leg part, a laminate which comprises a flexible, windproof and water-rejecting membrane which forms the outer surface of the laminate and which forms at least a barrier to biological noxiants, a carbon layer which is disposed underneath the membrane and which comprises carbon in fibrous or particulate form, and an inner textile ply.

[015] The lower leg protective apparel of the present invention offers a high level of wear comfort as well as protection against chemical and/or biological noxiants. It is very flexible and can be worn like a "normal" stocking or sock. More particularly, the lower leg protective apparel of the present invention can be put on before the suit is put on, and this means that in the event of deployment a person wearing a protective suit will be dressed more quickly and, what is more, possesses superior freedom of movement.

[016] When the membrane is breathable in accordance with the present invention, wear comfort will be even superior.

[017] The outer leg part, when it is configured as a sock, can constitute an outside sock composed of wool, cotton, silk, polyester, polypropylene, polyamide, polyacrylic, modifications or mixtures thereof. The laminate of the present invention provides protection against chemical and/or biological noxiants. The windproofness of the membrane prevents wind getting into the carbon layer underneath and thereby impairing its performance. The waterproofness simultaneously prevents liquid chemicals wetting through or penetrating into the carbon layer, which would likewise lead to impaired performance.

[018] As well as acting as a barrier against biological noxiants, the membrane, if appropriately configured, will also act as a filter against noxiants.

[019] In the event that liquid noxiants do succeed in penetrating, they will disperse in the membrane and will generally be blocked out. To the extent that they are not blocked out, they will diffuse through the membrane so slowly that they arrive at the carbon layer in a state for which the carbon layer is effective. This mechanism greatly increases the number of chemicals against which a protective effect is achieved. Practical tests have shown that the laminate of the present invention possesses a distinctly superior and, most importantly, more prolonged protective effect than known materials.

[020] When hydrophilic membranes, such as polyester, polyether, polyester copolymer and the like, are used, for example, there will be no microporosity, and this provides a barrier against biological noxiants. However, water vapor molecules are nonetheless capable of passing through, water is not.

[021] Since the upstream membrane already provides some protective effect, the carbon layer underneath can be made thinner without impairing its performance. This appreciably increases the wear comfort, since the carbon layer, which traps the heat, is thinner.

[022] Examples of further advantageous materials for the membrane are cellophane-based materials, polyvinyl alcohol, polyacrylamides, polyurethanes and mixtures thereof.

[023] When microporous membranes, for example polytetrafluoroethylene, are used, breathability is achieved despite windproofness and waterproofness.

[024] It is advantageous according to the present invention to choose such a small pore size that only water vapor will pass through the small pores. Since biological noxiants are generally larger, they are thereby prevented from passing through.

[025] The carbon layer can comprise of a woven or loop-formingly knit fabric having 100% activated fibers or else activated carbon spherules which were applied to a supporting material.

[026] The wear comfort is more distinctly improved when, in addition to the outside leg part, an inside leg part is disposed on the inside surface, i.e., the wearer-facing side, of the laminate. The inside leg part may, if configured as an innersock, be made of manufactured fibers, for example polypropylene, polyamide, polyester, modifications and mixtures thereof.

[027] The textile ply can be a textile fabric which forms a mechanically protecting layer for the carbon layer. On the outside, the membrane, as well as its protective effect against noxiants, likewise forms a mechanically protecting layer for the fiber layer.

[028]

[029] Operative examples of the invention will now be described in outline with reference to the drawing, where

[030] Fig. 1 shows a side view of the present invention's lower leg protective

apparel as a protective sock;

[031] Fig. 2 shows a rear view of the protective sock according to **Fig.** 1;

[032] Fig. 3 shows a cut for a shaft of the laminate of the present invention;

[033] Fig. 4 shows a cut for a foot upper part of the laminate;

[034] Fig. 5 shows a cut for a sole of the laminate;

[035] Fig. 6 shows a much enlarged cross section through the construction of the protective sock; and

[036] Fig. 7 shows a much enlarged cross section through a protective sock in another construction.

[037]

[038] The lower leg protective apparel of the present invention will now be described with reference to a protective sock. It will be understood, however, that other forms of lower leg protective apparel, such as stockings for example, are possible in the design of the present invention.

[039] The protective sock depicted in Figures 1 and 2 comprises an outside leg part in the form of an outersock 1. In the interior of the outersock 1 is disposed a laminate 2 whose construction will be more particularly described hereinbelow with reference to Figures 6 and 7. On the inside, to complete the protective sock, an innersock 3 is disposed as inside leg part.

[040] The three plies, consisting of outersock 1, laminate 2 and innersock 3, are bonded together and are conjointly pulled on as one protective sock. The bonding between the three plies can take the form of sewing and/or adhering for example. The sewing can be effected for example in the region of the upper ends of the three plies and additionally also in the heel and foot tip region, for example by means of yarns.

[041] The innersock 3 may be hydrophilic, if appropriate. At the seam locations, the innersock 3 should be loop-drawingly knit from soft, fleecy spun yarn in order that pressure points on the foot may be prevented.

[042] When the innersock 3 is made longer than the laminate 2 and the outersock 1, the innersock 3 may be turned at the upper end outwardly over the laminate 2 and the outersock 1 in the form of a cuff, as indicated by the broken lines in Figures 1 and 2. In the case of a hydrophilic innersock 3, absorbed moisture can thereby be transported to the outside where it can evaporate.

[043] The outersock 1 and innersock 2 can be fabricated from a plurality of cuts. Of course, the outersock 1 and the innersock 3 can also be woven or loop-formingly knit without seam. The laminate 2 can be produced from three cuts, as shown in Figures 3 to 5. Fig. 3 shows the cut for a shaft 4 of the laminate. Fig. 4 shows the cut for a foot upper part 5 and Fig. 5 shows a cut for a sole 6 of the laminate. The same applies mutatis mutandis to the outersock 1 when it is likewise fabricated from cuts.

[044] The three cuts can be joined together by means of a flatlock stitch or a zigzag stitch, in which case the seams are sealed off with a waterproof material. The waterproof material can consist for example of a waterproof seam-sealing tape. Similarly, the three cuts may be bonded together by water- and gasproof adhesives, which likewise should form a barrier against noxiants.

[045] Fig. 6 shows a much enlarged cross section of the construction of the protective sock composed of three plies, namely the outersock 1, the laminate 2 and the innersock 3. Fig. 6 further shows the construction of the laminate 2, which consists of three layers. The outer, i.e., wearer-remote, side of the laminate 2 is formed by a membrane 7. Underneath the membrane 7, i.e., on the wearer-facing side, there is a carbon layer 8, and a textile ply 9 is provided as an internal layer.

[046] The membrane 7, the carbon layer 8 and the textile ply 9 are laminated together in a known manner to form a single unit. This can be effected for example by a point-for-point lamination, in which case adhesive is applied dotwise between the two layers to be bonded together and the layers are then bonded together in the course of a passage through pressing rolls. The process of lamination can be carried out with or without heating.

[047] Fig. 7 shows in principle the same construction as the operative example of the protective sock according to Fig. 6. The sole difference is that, in this case, the innersock 3 is missing, so that the textile ply 9, which in this case will be made hydrophilic, of the laminate 2 is next to the foot of the wearer. The membrane 7 is flexible in order that it may stretch both in the transverse direction and in the longitudinal direction and rupture may be avoided.

[048] When the carbon layer 8 is a fabric, very good washing properties are obtained.

[049] The active carbon layer 8 can be produced in fiber form from a loop-drawingly knit or woven fabric. To produce active fibers of carbon it is known to

subject viscose fibers or a woven or loop-drawingly knit viscose fabric to a controlled combustion which is directed such as to produce activated carbon having extremely fine pores which then generate the filtering effect.

[050] The thickness of the carbon layer 8 can be between 0.2 to 1.0 mm and preferably between 0.4 to 0.8 mm.

[051] Advantageous active surface areas for the carbon layer 8 are in a range from 800 to 2000 m^2/g and preferably between 1000 to 1200 m^2/g.